

The other half of the coastal State Forest estate in New South Wales; the value of informal forest reserves for conservation

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ABSTRACT

There are 5.2 million hectares of public native forest within the coastal Integrated Forestry Operations Approval (IFOA) regions in New South Wales on and east of the Great Dividing Range. 4.3 million hectares or 83% of these forests are set aside in formal or informal conservation reserves. State Forests which comprise 1.55 million hectares or 30% of the public estate within the coastal IFOA regions in New South Wales are managed for a variety of reasons including timber production, recreation, and conservation. While commonly associated with timber harvesting, 43% (675,717 hectares) of the native State forest estate is set aside for conservation in informal reserves.

State forest conservation areas include formal Flora Reserves, and a suite of informal reserves including riparian protections, ridge and headwater connection, old growth patches, rare and non-commercial forest types, rainforest, heath, rock outcrops, steep slopes, wildlife corridors, large forest owl protection areas and species specific exclusion zones. These informal reserves receive legal protection via the State Forest Management Zones (FMZ) across the landscape. These informal reserves facilitate the movement of forest fauna and provide important habitat for a unique subset of species. When harvesting occurs in adjoining forest land the reserved areas provide refugia and opportunities from which re-colonisation can occur. Additionally and importantly, the juxtaposition of the undisturbed forest in informal reserves and open areas created by harvest operations creates an ecotone and a variety of successional forest habitats.

In addition to describing the current extent of these areas in State Forests in eastern NSW, we reviewed research that assessed their effectiveness as a complementary conservation measure to formal Reserves. Our review indicates that there is a considerable body of knowledge supporting their effectiveness at the local level. To date, however, there has been limited investment in extending and testing these findings more broadly across the landscape.

The current forestry regulatory framework is a mix of broad landscape exclusions, general protective conditions implemented routinely regardless of the result of biodiversity surveys and also the option of implementing a condition in lieu of survey, but relies heavily on localised pre-harvesting surveys of threatened species. The costly nature of these surveys and the requirement for these surveys to comply with licence conditions, however, limits the ability to undertake post-harvest surveys or monitoring on a broader scale with available resources. A new model is currently being developed whereby minimum standards are set for informal reserves across the landscape, in conjunction with local scale protection of key habitat features. The new direction has arisen from recognition that effective biodiversity conservation demands a holistic approach. However, the effectiveness of this approach and proposed retention thresholds needs to be rigorously monitored. This would require transferring effort from pre-harvest surveys towards monitoring occupancy trends and status of biodiversity over time.

Key words: Informal reserves, Monitoring, Integrated Forestry Operations Approval, reservation, forestry, harvest exclusions, surveys

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Introduction

Forest management zoning is a commonly used process by Australian forestry agencies to designate permissible activities within zones to sustainably manage the landscape (e.g. State Forests of NSW 1999, Forestry Tasmania, 2006, Dept. of Parks & Wildlife, West Australia 2014). Forest Management Zones were designed as part of the

Comprehensive, Adequate and Representative (CAR) Reserve system using nationally agreed criteria based on categories specified under the International Union for Conservation of Nature (State Forests of NSW 1999). The zones define areas to be managed for conservation and those managed for other values including timber

production (State Forests of NSW 1999). The CAR reserve system includes dedicated reserves (national parks, nature reserves, flora reserves), Informal reserves within State Forests (old-growth, river and stream zones, travel route zones and diverse ecotype zones (Dept. of Parks & Wildlife, West Australia 2014), and other management prescriptions.

Informal reserves in conjunction with selective harvesting practices provide areas of undisturbed forest which ensure that key habitat components are not depleted at the local level. Old growth elements in particular require special protection given the time it takes for these to develop (Mackowski 1984). In New South Wales (NSW), informal reserves are areas of land specified within the Integrated Forestry Operations Approvals (IFOA) (Table 1). Flora Reserves are an example of a formal reserve within State Forests, with management plans prepared and excluded from timber harvesting. Importantly, Flora Reserves require formal legal action to revoke as a land tenure in the same manner as that of National Parks or Nature Reserves in NSW.

Table 1 – Examples of Informal Reserves within State Forests of NSW and the scale over which they are implemented.

Landscape	Localised
Creek & stream exclusions	rare & non-commercial forest types rainforest
Ridge & headwater corridors	heath rock
Large forest owl exclusions	old growth patches species specific exclusions

Informal reserves are viewed as one of the strategies for conserving biodiversity in production landscapes. Additional measures are also essential to complement a 'reserve' system in production forests, but they are not reviewed in this paper. These include the retention of hollow trees, recruits and other specialised resources such as sap and flower feed trees within the net harvesting area (referred to as wildlife prescriptions) which provide a scattering of hollow and feed resources across the landscape (Meek 2004, Kambouris *et al.* 2014).

The aim of this paper is to describe the function of informal reserves in State Forests of NSW and their value for wildlife conservation. We describe the current extent of informal reserves in State Forests and review the evidence for the effectiveness of this approach for achieving its purpose of maintaining viable wildlife populations across the landscape. Finally, we consider future changes to maximise the benefits of retaining informal reserves and ensuring that its effectiveness is properly measured and reported.

Informal Reserves – habitat value context

The value of informal state forest reserves needs to be considered in the context of the extent and proximity

of existing formal reserves, the nature of timber harvesting and the health and condition of the State forest that is being subject to timber harvesting. There are 5.2 million hectares of public native forest within the coastal Integrated Forestry Operations Approval (IFOA) regions in New South Wales on and east of the Great Dividing Range. 4.3 million hectares or 83% of these forests are set aside in formal or informal conservation reserves. While commonly associated with timber harvesting, 43% (675,717 hectares) of the native State forest estate is set aside for conservation in informal reserves (Table 2).

At a more local scale, remnants of mature forest in a matrix of regenerating forest provide very different habitat value compared to those embedded in agricultural paddocks. In timber production forests, the regrowth matrix comprises patches of vegetation cohorts which regenerate following disturbance by management activities. Some species will tolerate the regenerating matrix better than others and the extent to which it is used changes over time as the matrix itself recovers from disturbance (Kavanagh and Stanton 2003). This local landscape context is likely to have important effects on the extent of informal reserves that are required by different species.

The retention of old growth elements within mature forest allows some species with stringent habitat requirements (especially for tree hollows) to persist within otherwise unsuitable 'early' growth stages. These reserved mature forest areas allow recolonisation of regenerating stands by providing source populations from which new recruits can establish populations or expand local areas of occupancy, such as for Greater Glider *Petauroides volans* (Kavanagh and Wheeler 2004). They also allow for movement of individuals, and migration, through the landscape by using the linear strips either through riparian areas or over upper slope areas via ridge and headwater corridors.

It is well known that a suite of species require advanced successional growth phase elements for denning and nesting opportunities within their home ranges, (i.e. hollow dependent arboreal mammals including Yellow-bellied Gliders *Petaurus australis*, Greater Gliders, large forest owls and insectivorous bats). There is also another suite for which earlier successional forest phases are required to provide optimal habitat; e.g. a variety of small ground dwelling mammals and reptiles. Fox (1996) and Monamy and Fox (2000), showed successional changes in species occupying sites following fire disturbance that are driven by changes in vegetation complexity, resource requirements and interspecific interactions. Timber harvesting reduces the age class of trees remaining in the net harvesting areas within current regime cycles, which highlights the value of and need for protection of the older age class stands. Thus a multi-aged forest environment is important in providing appropriate habitat for a range of species.

Table 2. Breakdown of reserved area in public land across the coastal IFOA regions in NSW including the % of protected land within the State Forest estate presented in hectares as at November 2014. NP Area is the area of National Park, SF Reserve refers to informal and formal reserves that are excluded from logging, SF available refers to the areas of state forest that are available for logging, % Protected is the combined NP area and SF Reserve expressed as percentage of the Public land, % SF Area Protected is the SF reserve expressed as a percentage of the total SF area (SF reserve and SF Available).

IFOA REGION	NP Area	SF Reserve	SF Available	Public Land	% Protected	% SF Area Protected
Eden	252,383	81,717	125,213	459,312	73%	39%
South Coast Sub Region	572,334	70,965	141,674	784,973	82%	33%
Tumut Sub Region	806,910	156,302	51,855	1,015,067	95%	75%
Lower North East	1,373,726	193,333	302,182	1,869,241	84%	39%
Upper North East	664,414	173,400	257,666	1,095,481	76%	40%
Total	3,669,767	675,717	878,590	5,224,074	83%	43%

Historical Development of Informal Reserves

The first *Forestry Act* (1909) was an outcome of a Royal Commission into the rapid clearing of forests for agriculture and uncontrolled cutting of timber at the turn of the 20th century (Curtin *et al.* 1991). The Forestry Commission of NSW was created as a consequence, with State Forests dedicated for the purposes of managing the State's timber resources.

Flora Reserves were also dedicated under the *Forestry Act* (1909), which aimed to protect rare and outstanding examples of forest types with minimal human disturbance. In 1984, these formal reserves covered 18,200 ha across 87 reserves on the north coast of NSW alone (Curtin *et al.* 1991). These are typically small sized (median ~ 290 ha) and scattered, meaning they functioned more for the protection of plants than wildlife. Many of these reserves were subsumed into the National Park estate following the Regional Forest Agreement process of the 1990's. In 2015 there was a total of 37 reserves on the North coast of NSW covering 8597 ha (FCNSW unpublished data).

Reservation of forest for the purpose of biodiversity conservation was much slower to eventuate. An overview of the historical development of fauna management and wildlife research in State Forests of NSW has been provided elsewhere (Curtin 2004; Shields 2004). However, these accounts provide little detail about the emergence of retained forest as a key issue in biodiversity conservation within timber production forests.

Many of the forest retention practices now employed on State Forests saw their initial development in Eden in the late 1960s where higher intensity integrated harvesting for sawlogs and pulpwood was practised. Early management practices at Eden were based on wildlife studies carried-out between 1975 and 1978 (e.g. Recher *et al.* 1980). These focused on retaining unlogged strips along creeks and in gullies and retention of habitat trees in the net harvesting area. Other patches of unlogged forest were routinely retained on rocky terrain, steep slopes and in

non-commercial areas. Over time riparian strips, originally retained for erosion control and to protect water quality, were widened and extended over ridge-lines to join adjacent catchments, to improve their value for flora and fauna.

Recher *et al.* (1987) were among the first to evaluate these practices in relation to theory and preliminary research results. For example, they investigated the value of small unlogged coupes adjacent to logged coupes and riparian buffers retained in forest cleared for pine plantation. They concluded that the retention of mature forest, such as riparian areas and patches on steep or rocky ground offered refuge in the short term, but data were not available on their long-term value. Further recommendations were made that included 1) widening of riparian buffers from 20 m to a minimum of 50 m either side of creeks, 2) riparian strips to follow ecological boundaries, such as the natural interface between riparian and slope forests, 3) retention of large patches of unlogged forest (~ 100 ha) within the harvesting area, ideally adjoining creek reserves and gullies and including slope and ridge habitat (the proposal was to 'string beads on the existing reserve necklace'). Claridge and Lindenmayer (1994) further highlighted the importance of habitat outside of gullies for many fauna, such as bandicoots and potoroos, and suggested there was a need to retain habitat on mid-slopes and ridges.

While some of these recommendations were adopted, such as over-ridge corridors to connect adjacent catchments, the retention of large blocks of forest did not emerge in NSW until the 1990s. The 1990s saw a greater awareness around the world of the importance of managing timber production forests for biodiversity conservation, which stimulated further calls to retain, among other things, unlogged forest for wildlife (e.g. Lindenmayer and Franklin 1999). In particular, retention across spatial scales ranging from a few metres (e.g. one hollow tree) to hundreds of metres (patch of forest) was emphasised to provide for a heterogeneous landscape, though guidance on the size of large patches was lacking. During this period in NSW, more sophisticated wildlife prescriptions were developed, partly in response to greater knowledge of the habitat requirements of previously

cryptic groups of fauna such as large forest owls, frogs and bats (Nicholson 1999). For example, prescriptions to protect forest owls involved landscapes of extensively forested areas of state forest (5000–15 000 ha) in which there have been numerous owl sightings (Kavanagh 2002). The approach specifies that a minimum of 25% of the forest planning area must be retained in exclusion zones containing suitable habitat. While formal reserves can be used to meet the requirements of exclusion zones, at least 10% of the retained area must be outside statutory reserves. Of the areas to be retained in Forestry Corporation NSW (FCNSW) estate outside of statutory reserves, a minimum of 30% must be retained in patches at least 50 hectares in size, with the shape of exclusion zones to minimise the boundary to area ratio.

A brief summary of the more recent history detailing the development of the current National Park reserve and management zones within State Forests is provided below:

- National Forest Policy – detailed the requirements for a Comprehensive and Adequate Reserve System (CAR Reserve System) under the JANIS¹ criteria, which aimed to protect 15% of each forest type as existed before European arrival, at least 60% of old-growth forest and 99% or more high quality wilderness (Commonwealth of Australia 1997)
- Comprehensive Regional Assessments (CRA) – undertaken in the late 1990s, provided details enabling the development of the CAR Reserve system along with Regional Forest Agreements
- The CAR reserve system includes dedicated reserves (national parks, nature reserves, flora reserves), Informal reserves within State Forests (old-growth, river and stream zones, travel route zones and diverse ecotype zones (Dept. of Parks & Wildlife, West Australia 2014),
- Additional management prescriptions as specified in other regulatory requirements such as the Integrated Forestry Operations Approvals (IFOA) were also developed as part of these processes (Forestry and National Park Estate Act 1998); now regulated by the Environment Protection Authority (EPA) within NSW.

Current Extent of Informal Reserves on State forest land in coastal NSW

The current extent of reservation within the coastal state forest estate varies across IFOA regions (Table 2), though they make up a considerable portion of the state forest estate ranging from 33 to 75% of the South Coast and Tumut sub-IFOA regions, respectively (Figure 1). These area values constitute the range of the above-listed

¹ 'JANIS' stands for the Joint ANZECC/MCFFA National Forest Policy Statement implementation Subcommittee, which developed the criteria.

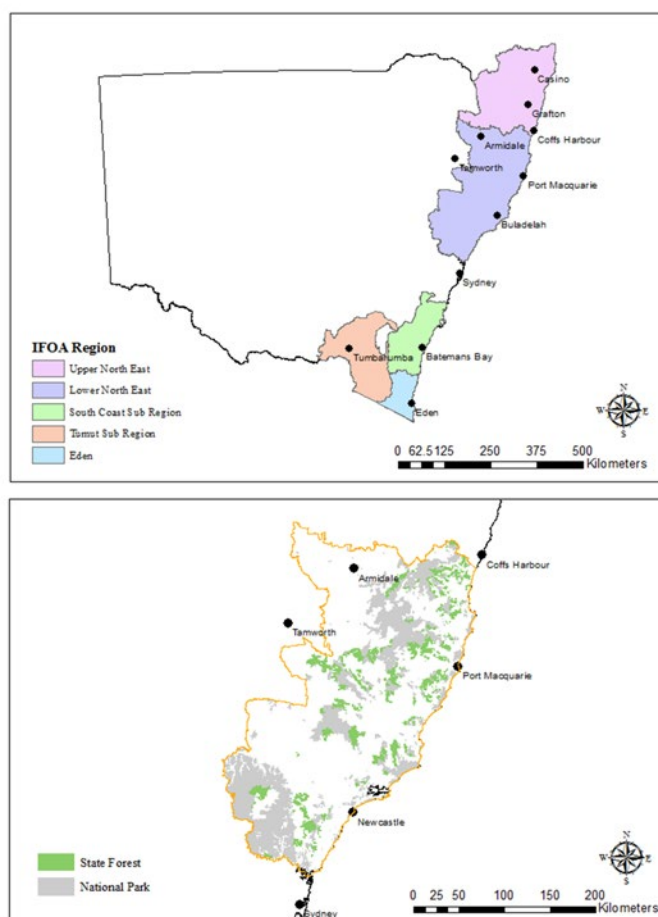


Figure 1. Coastal IFOA regions within NSW and the Lower North East IFOA region indicating State Forest and National Park areas.

exclusions and can be over-represented in discrete areas. The reservations are made up of a mixture of formal and informal reserves managed at varying land unit scales from regional to a local harvest event level of between 200 and 500 ha (Figure 2). Breaking this down by reserve category in one region (Lower North East IFOA region), indicates that the greatest contributions to informal reserves come from owl landscapes, rainforest, drainage buffers and old growth forest (Table 3).

Effectiveness of Informal Reserves for Achieving Conservation Outcomes

Up until the last 15 years, investigations of the effectiveness of informal reserves were limited and few data were available, especially for assessing long-term conservation success for forest fauna (Lindenmayer 1994). What evidence is there now that informal reserves contribute to conservation? A sample of case studies is outlined below for a range of taxa where the relevance of informal reserves has been an integral component of the studies or conclusions. While not all of these studies were designed to test the effectiveness of particular informal reserves *per se*, they do provide valuable information on how

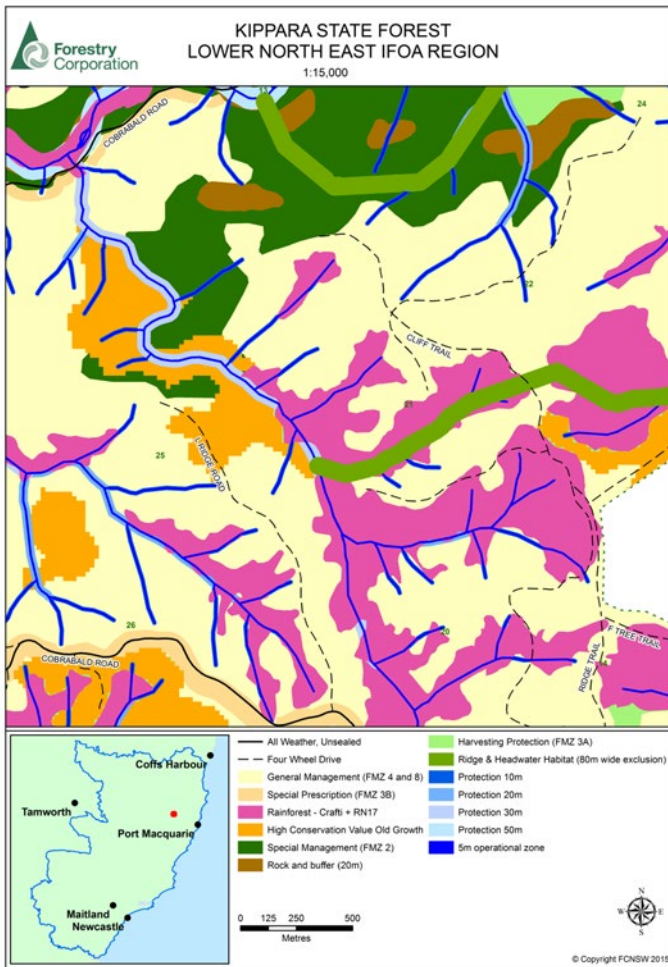


Figure 2. Kippara State Forest, map of several adjacent compartments indicating the range of informal reserves from north–west of Port Macquarie in the Lower North East IFOA region.

Table 3. Lower North East IFOA region break–down of reserved area by category as at November 2014. Reserved areas overlap in some instances, for example rainforest and riparian exclusions, values represented equate to the individual layer’s contribution to the reserved area value.

Reserve Area Type	% Of Reserved Area
Owl Landscape	35.5%
Rainforest	28.3%
Drainage	24.0%
High Conservation Value Old Growth	17.5%
Ridge & Headwater	5.3%
Rare Non Commercial	1.6%
Rock	1.4%
Wetland	0.7%
Heath	0.1%
Other	7.1%

different components of the landscape are used and allow an assessment of the value of informal reserves for fauna conservation. The examples outlined also clearly highlight the need for further testing of the effectiveness of informal reserves to tease out which parts of the overall design contribute most benefit. This is likely to be best achieved as part of an adaptive management process that includes the ability to update management practices (Meek 2004). Adaptive management is especially important where targeted reservation is found to be inappropriate, as has been argued for the current approach to species such as Hastings River Mouse *Pseudomys oralis*, which may require some form of disturbance (Meek 2004).

Insectivorous bats are the most diverse component of mammal fauna in the forests of NSW, 22 species are listed as threatened and they have been the subject of extensive research over the last 20 years. For example, Lloyd *et al.* (2006) measured bat activity with ultrasonic detectors in informal reserves along streams across four different stream orders in logged, regrowth and mature forests near Coffs Harbour (60 sites). Bat activity, foraging rates and species richness were similar in stream reserves surrounded by logged, regrowth and mature forests, suggesting that these reserves effectively provide habitat for foraging and commuting bats in selectively logged forests. Bat activity along paired forest trail flyways on upper slopes (60 sites) was measured simultaneously with riparian flyway activity (for a total of 120 sites) to determine the importance of riparian areas relative to other available flyways. Activity was higher on upper slopes than on small streams, but similar to levels on larger streams, indicating bats also use flyways extensively in the regrowth matrix outside of informal reserves.

The Golden–tipped bat *Kerivoula papuensis* is an example of a highly specialised species (Figure 3) that roosts in



Figure 3. Golden–tipped Bat *Kerivoula papuensis* was the subject of radio–tracking studies over a 12 year period to assess the effectiveness of informal reserves that included rainforest and riparian protection (Law unpubl. data). Photo: B. Law.

the suspended nests of Yellow-throated Scrub-wrens *Sericornis citreogularis* and Brown Gerygone *Gerygone mouki*, typically in rainforest gullies and feeds on orb-weaving spiders (Law and Chidel 2004). To assess whether Golden-tipped bats persisted in retained rainforest, riparian strips and other informal reserves after harvesting, radio-tracking on the south coast of NSW was undertaken one year before harvesting as well as 1 and 10 years post-harvesting (Law unpubl. data). Radio-tracking found that harvesting did not affect scrub-wren nest availability in rainforest and Golden-tipped bats continued to roost and breed in riparian rainforest 'reserves' after harvesting. Harvesting reduced orb-weaver spider abundance in the short term, but they had recovered after 10 years. Bat capture rates were consistent with the response of spiders, with a short term impact of harvesting and recovery after 10 years.

Frogs are another taxa that are typically associated with riparian areas. Retaining native forest corridors linked to native forest patches appears to provide sufficient habitat for many frogs, even in pine plantations. An assessment of streamside reserves after pine plantations were established in adjacent areas found that 9 of 14 (64%) frog species recorded soon after plantations were established were still present 20 years later (Lemckert *et al.* 2005). The study concluded that frogs using streams embedded within pine plantations mostly remain similar to those found on streams bordering tracts of native forest. However, larger species of frogs, such as the Giant Burrowing frog *Heleioporus australiacus*, were not detected and it may find such corridors insufficient for long term survival. Such a study of informal reserves in pine plantations helps to establish the minimum requirements for the survival of wildlife in a linear environment. Further work on *H. australiacus* in native forest near Eden demonstrated it spent little time near riparian breeding areas (Penman *et al.* 2008). The study concluded that existing informal reserves and exclusions around site records were inadequate for this species and instead protection of key populations was proposed. This has been implemented via a specific species management plan that has identified three populations from which harvesting has been excluded and includes monitoring to assess the continued viability of populations. The requirements of this frog contrasts with that of the Giant Barred Frog *Mixophyes iteratus* (Figure 4) which has been studied in native forest by tracking their movements with spool-and-line (Lemckert and Brassil 2000). All frogs were captured and recorded moving within a 20 m wide band either side of streams, suggesting informal stream-side reserves were effective for this species, noting that native forest, not pine plantation, surrounded the site.

The Eastern Pygmy Possum *Cercartetus nanus* is a species not considered to be closely linked to riparian zones and in forests it is more commonly associated with drier upper

slopes where nectar producing plants can be abundant (Law *et al.* 2013). As such, it may be more vulnerable to disturbance from harvesting given the concentration of informal reserves along gully lines. A radio-tracking study of this species found no change in mean home range size before and after harvesting (Law *et al.* 2013). About 50 % of dens were located in post-harvesting regrowth, indicating that flexibility in den use aids their tolerance of disturbance. Although possums did not select the unlogged areas within their home range in preference to logged areas, the remaining 50 % of dens were located outside of the net harvesting zone and informal reserves (such as over-ridge corridors and high conservation value old growth) are an important contributor to such areas. These results also suggests that small informal reserves around new survey records of potentially transient animals would be less effective than a program of systematic landscape retention.

Application of landscape protection (25 % of 5,000 to 15,000 ha landscapes) for owls also had preliminary evidence for success. Early monitoring of this approach found that owl populations persisted at detectable levels, in similar proportions before and after harvesting, for at least 2–4 years (Cann *et al.* 2002). Recent results from the southern tablelands area of NSW suggest similar results for large forest owls and Yellow-bellied Gliders after 20 years, with glider occupancy rates higher than the original sampling in 1995 (Kambouris *et al.* 2014). While these results are encouraging for owls and the Yellow-bellied Glider, longer-term monitoring is essential to assess the effectiveness of this approach over longer periods for a range of species.

An example of how small-scale retention of tree patches (in effect, small reserves) benefit biodiversity is described in a longitudinal study in eucalypt plantations on the north coast (Law *et al.* 2014). The study began in a farmland mosaic and has continued to follow fauna



Figure 4. Giant Barred Frog *Mixophyes iteratus* was spool and line tracked and found to move within a 20 m wide band either side of streams (Lemckert and Brassil 2000). Photo: F. Lemckert

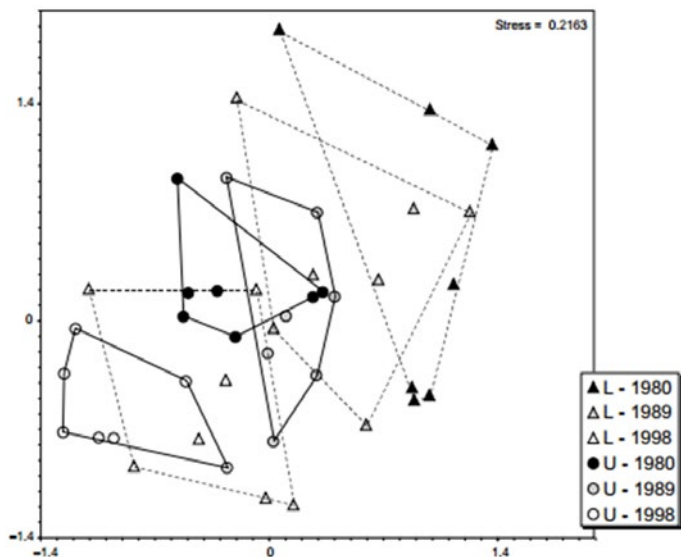


Figure 5. Similarity in bird assemblages on logged and unlogged coupes in 1980, 1989 and 1998 (after Kavanagh and Stanton 2003). Polygon groupings are made by treatments within each year. Logged coupes groups by broken lines, unlogged coupes grouped by solid lines.

occupancy rates over 17 years after the establishment of eucalypt plantations within the paddock areas. Surveys are undertaken at focal trees located in different classes of remnant vegetation (including single large, relict trees and clumps), which became embedded within the plantations as well as in the plantation matrix itself. For diurnal birds, retention of remnant vegetation at the time of plantation establishment contributed considerably to the biodiversity present in the plantations and it is likely to provide key refuge areas during any subsequent harvesting (Law *et al.* 2014). Similar results have been found in Victoria for small retention areas (0.5 ha) in clear-felled forest supporting populations of small mammals and allowing for recovery as the forest regenerates (Lindenmayer *et al.* 2005; Lindenmayer *et al.* 2010). In the case of small mammals, single habitat trees are unlikely to provide this benefit.

Finally, one of the longest ecological studies in Australia that is now nearing 40 years investigated recovery of diurnal birds to intensive harvesting at Eden (Kavanagh *et al.* 1985; Kavanagh and Stanton 2003). One of the original aims of this study was to investigate the importance of small unlogged patches as refugia and sources of recovery for bird populations. Such unlogged patches represent informal reserves, though they are temporary during the harvesting cycle, rather than in perpetuity. The study began in the 1970s when no old trees were retained in logged areas and no stream-side reserves were retained. However, intensive harvesting took place as a patchwork of small (~15 ha) alternate coupes, with unlogged coupes retained adjacent to logged coupes to maintain landscape heterogeneity. The study found that recovery on logged coupes had occurred for many species after 13 years

and that, after 22 years, the bird assemblages on logged and unlogged coupes had largely converged (Figure 5). The presence of nearby unlogged forest patches presumably aided recovery time on the logged coupes. Notably, some hollow-nesting species (e.g. White-throated Tree-creepers *Cormobates leucophaea*) had not fully recovered on logged coupes, emphasising the importance retaining old or 'habitat trees' on the logged areas themselves.

Replacing Surveys with Monitoring

Given that the studies reviewed above often represent localised case studies that were not always designed to test management effectiveness, we suggest that long-term monitoring of the landscape network of informal reserves (e.g. corridors) is now needed. Because trend monitoring tracks changes in response variables (e.g. species status or occupancy), hypothesis driven research will be needed to determine causality behind documented declines (e.g. Lindenmayer 1994).

Implementation of a landscape monitoring program is limited by the costs of the current management, as prescribed by the Integrated Forestry Operating Approvals (IFOAs) (Forestry Act 2012). The IFOA describes the requirements of surveys, and currently these are undertaken prior to harvesting. This includes a range of techniques targeting a range of fauna and flora species, such as compartment traverse (targeted meander through areas of forest), small mammal trapping targeting Hastings River Mouse, bat trapping targeting the Golden-tipped Bat, call broadcast for frogs including Stuttering Frog *Mixophyes balbus*, Giant Barred Frog *M. iteratus*, arboreal mammals Yellow-bellied Glider and nocturnal birds Powerful Owl *Ninox strenua*, Masked Owl *Tyto novaehollandiae*, spotlighting Brush-tailed Phascogale *Phascogale tapoatafa* and other species specific techniques for species such as the Rufous Scrub-bird *Atrichornis rufescens*. These surveys are very labour intensive and, while carried out by highly skilled specialist staff, do not provide data on long term trends or the effectiveness of protective measures because sites are not revisited post-harvesting, due mostly to their design of complying with licence conditions rather than being appropriate for repeat surveys. This is widely recognised (Meek 2004; Law 2004; Kavanagh *et al.* 2004; Lunney and Matthews 2004) and an opportunity now exists for a more meaningful approach to be incorporated into the reviews of the coastal IFOAs presently underway. The review is considering a broad landscape based monitoring program supplemented by species specific monitoring and targeted research projects on species for which the broad landscape monitoring is unsuitable. Such an approach is urgently needed so that reporting can be undertaken on occupancy trends and broad-scale effectiveness of protective measures.

There are also a clear economic and social benefits to monitoring compared to pre-harvest surveys. Monitoring

surveys could be undertaken strategically and in a manner that allows for repeat sampling over subsequent periods providing robust data for statistical analysis of trends. Trends would be detectable over the broader area over time providing an improved understanding of persistence of populations in the landscape. Ideally a program like this should be undertaken over multiple land tenures including State Forests, national parks and private land. The value of the data will be significantly higher, given the robust manner of collection for a long term goal, for similar expenditure, compared to surveys that are undertaken to comply with a set of conditions that are very often unworthy of repeating for this purpose. This will lead to improved ability to report results and provide a transparent understanding of the management of biodiversity for the broader community and the ability to adaptively react to unacceptable levels of change. The continuation of the current survey approach will at best, only continue to add more records of species as a trigger for management, but with minimal capacity to adaptively learn about the health of biodiversity in the forest.

Review of Current Forestry Practices in NSW

Following 17 years of implementation of the IFOAs within the coastal areas of NSW, a review is currently underway. This is looking to place greater emphasis on landscape retention of unharvested forest, while also embracing multi-scale forest management (Lindenmayer and Franklin 2002). The multi-scale management includes the retention of habitat trees and recruitment trees along with clumps (targeting threatened species habitat) within the net harvesting areas. Landscape reserves are arguably of most importance with a recent review recommending the retention of least 10 % of the landscape (Gustafsson *et al.* 2012). In agricultural landscapes, where trees have been cleared, a target figure of 10–30 % retention is often proposed (e.g. Andren 1994; Radford *et al.* 2005). A recent study in Tasmania compared the biodiversity of birds, beetles and vascular plants in silvicultural regeneration forest plots with near-by mature eucalypt forest plots (Wardlaw *et al.* 2012). The closer a regeneration forest plot was to a patch of mature forest the more abundant and/or species rich it became. Cover of rainforest plants increased until within a 150 m threshold of proximity to mature forest, which corresponded to 28 – 31% mature eucalypt forest within 1 – 4 km landscapes. The abundance of dense-forest birds increased until within 400 m threshold of proximity to mature forest, which corresponded with 11 – 16% mature eucalypt forest in 1 – 4 km landscapes. Wardlaw *et al.* (2012) made the following recommendation to ensure that a high proportion of the harvest area is sufficiently close

to the retained mature forest for disturbance-sensitive species. Retain at least 12–22% of mature eucalypt forest in the surrounding 1 km landscape to ensure that the retained mature forest continues to sustain populations of disturbance-sensitive birds and plants in the surrounding production landscape.

The current proposal for forests in NSW, as part of the IFOA review, is a minimum retention of 20% of each local landscape area (1500 ha). While the figures in Table 2 show substantially more reservation currently occurs across the entire region than 20%, particular State Forests with extensive reserves contribute greatly to this figure, while others with few informal reserves fall below the 20% threshold. The aim of the revised IFOA is to set a minimum for each 1500 ha landscape unit. It has been proposed that existing informal reserves will not be reduced in size, which would lead to an increase in the overall reservation by IFOA region. Most importantly, they will be spread spatially more evenly than is currently the case, especially in areas currently zoned as coastal regrowth forest.

While there is considerable evidence to support the value of landscape retention of unharvested forest (e.g. Lindenmayer and Franklin 2002; Gustafsson *et al.* 2012; Wardlaw *et al.* 2012), there are few data to identify the threshold level of retention. Recher *et al.* (1987) stated “the extent of unlogged forest retained is variously estimated at 10 to 25% of the total forested area available for harvesting within the Eden region, but the *exact area* which will remain unlogged outside parks remains to be confirmed”. Almost 30 years later and there is still argument over what this figure should be. Whatever threshold is agreed upon, it is clear that biodiversity monitoring must be a key component of adaptive management and testing the effectiveness of informal reserves within a landscape approach to biodiversity conservation.

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APPENDIX I



Riparian habitat, Bellangry State Forest, Mid-north coast of NSW December 2015. Photo: C. Slade.



Large hollow bearing "Habitat tree", Blackbutt, *Eucalyptus pilularis*, Mount Boss State Forest, Mid-north coast of NSW, December 2015. Note the number of visible hollows suitable for a range of fauna species including large forest owls and arboreal marsupials including possums and gliders. Photo: C. Slade.

APPENDIX I



Forestry Corporation of NSW Ecology and Hydrology staff undertaking aquatic macro-invertebrate sampling as part of water quality monitoring. Mount Boss State Forest, Mid-north coast of NSW, November 2015. Photo: C. Slade.